TRANSLATION CERTIFICATION

This is a complete and accurate translation by us, to the best of our knowledge and ability, from German into English of:

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TRANSLATION (P/4325-7-original):

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METHOD FOR OPERATING AN INTERNAL COMBUSTION ENGINE

The invention concerns an internal combustion engine, especially an internal combustion engine for a motor vehicle, with a charge air flow path, in which a compressor, an exhaust gas turbocharger, and a throttle valve are installed, such that an outlet of the compressor is connected with an inlet of the exhaust gas turbocharger, an air channel that bypasses the compressor is provided, and the throttle valve is installed downstream of the exhaust gas turbocharger, in accordance with the introductory clause of Claim 1. The invention also concerns a method for operating an internal combustion engine of this type in accordance with the introductory clause of Claim 2.

In the operation of an internal combustion engine, the task of charge determination is to determine the air mass in the combustion chamber as accurately and dynamically correctly as possible to provide a basis for adjustment of the manipulated variables. There is no direct measurement. The various known measuring principles are more or less accurate due to their indirect measuring method. The most widely used method with a hot-film air flowmeter is dynamically inexact, especially in supercharged engines, due to insufficient proximity to the combustion chamber, since long distances in the air flow path result in time delays and storage effects. In addition, charge-influencing actuators, such as the charge control valve (LBK), camshaft, tank ventilation, and exhaust gas recycling (EGR), and the components exhaust gas turbocharger (ATL) and compressor have a strong effect on the charge and thus on the manipulated variables of the engine.

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EP 0 879 345 B1 describes a supercharged piston engine that has both an exhaust-driven turbocharger and a mechanically motor-driven compressor, whose delivery side is connected with the intake side of the turbocharger. A disengageable clutch is provided between the engine and the mechanical compressor. Depending on the engine speed and the engine load, the clutch between the engine and the mechanical compressor is engaged, and the clutch is blocked if the engine load falls below a predetermined level. If an exhaust gas braking device is actuated, then engagement of the clutch is allowed regardless of whether the engine load is below the predetermined level. Since the mechanical compressor should only be operated at low engine speeds, a switching valve is provided, which actively switches both chargers or actively switches only the turbocharger between the operating modes by closing or connecting the corresponding airways. This switching valve switches only between the air flow path that runs through the compressor and the air flow path that bypasses the compressor. Therefore, a second control valve is additionally required, which is used to control the mechanical charger and normally realizes recirculated-air control.

The objective of the present invention is to improve a twin supercharged internal combustion engine of the aforementioned type with respect to the mechanical design and the control process.

In accordance with the invention, this objective is achieved by an internal combustion engine of the aforementioned type with the features specified in the characterizing clause of Claim 1 and by a method of the aforementioned type with the features specified in the characterizing clause of Claim 2. Advantageous refinements of the invention are specified in the dependent claims.

For this purpose, in an internal combustion engine of the aforementioned type, the invention provides that a compression throttle valve is installed in the air channel that bypasses the compressor. This valve selectively closes exclusively this air channel that bypasses the compressor in a continuously variable way and controls compression of the compressor.

In a method of the aforementioned type, the invention provides that the compressor is shut off by fully opening the compression throttle valve and disengaging a clutch between the compressor and the crankshaft as soon as the mass flow that the exhaust gas turbocharger is able to deliver on the basis of an exhaust gas mass flow $\dot{m}_{abg}$ exceeds the delivery volume of the compressor.

This has the advantage that supercharging by the compressor is realized in a low engine speed range, and that, starting at a certain engine speed, above which the exhaust gas turbocharger guarantees sufficient supercharging, the compressor can be shut off.

When the internal combustion engine is running at full load, it is advantageous for the compression throttle valve to be completely closed until the exhaust gas turbocharger begins to exhaust the volume after the compressor.

Additional features, advantages and advantageous refinements of the invention are specified in the dependent claims and are explained in the following description of the invention with reference to the attached drawing. The sole figure is a schematic representation of the air flow path and the exhaust gas end of a twin supercharged internal combustion engine.

As the sole figure shows, the internal combustion engine comprises an air flow path, in which the following are installed: an air filter 10, a compressor 12, an air channel 14 that bypasses the compressor 12, a compression throttle valve 16 for selectively closing the air channel 14, an exhaust gas turbocharger 18, a supercharger intercooler 20, a throttle valve 22,

and an intake manifold 24, which opens into the several combustion chambers in a cylinder crankcase 26 of the internal combustion engine. A waste gate 30, which admits a flow of exhaust gas to a turbine 32 of the exhaust gas turbocharger 18, is installed on the exhaust manifold 28. The exhaust gas turbocharger 18 also includes a compressor 33. An outlet of the compressor 12 opens into an inlet of the exhaust gas turbocharger 18. The compressor 12 is driven by a belt 34 from the crankshaft of the internal combustion engine. In this regard, the drive of the compressor 12 can be selectively disengaged from the crankshaft by means of a clutch 36, for example, a magnetic clutch. The concept of this system is to realize supercharging by the compressor 12 in a low engine speed range and to shut off the compressor 12 starting at a certain engine speed, above which the exhaust gas turbocharger 18 guarantees sufficient supercharging. Sensors 38, 40, 42, and 44 measure, respectively, a pressure p_{vATL} before the exhaust gas turbocharger, a pressure p_{vDK} before the throttle valve 22, a pressure p_s in the intake manifold 24, and an ambient pressure p_u.

In the engine load or speed range in which the exhaust gas turbocharger 18 alone is not able to apply the desired boost pressure, the compressor 12 is switched on. Its compression is controlled by the compression throttle valve 16. In this range, the waste gate 30 adjusts to maximum compression of the exhaust gas turbocharger 18. In this regard, the throttle valve 22 acts as the control element of the intake manifold pressure p_s. The positions of the two valves 16 and 22 are computed in the above-described mass flow model by reverse computation and controlled in a coordinated way. As soon as the mass flow that the exhaust gas turbocharger 18 is able to deliver on the basis of the exhaust gas mass flow $\dot{m}_{abg}$ exceeds the delivery volume of the compressor or as soon as the desired boost pressure can be adjusted by the exhaust gas turbocharger 18 alone, the compressor 12 is shut off. The compression throttle valve 16 is fully

opened so as not to throttle the exhaust gas turbocharger 18. The compression of the exhaust gas turbocharger is regulated from this point on by the position of the waste gate valve 30. When the internal combustion engine is running at full load, the throttle valve 22 is completely open (boost operation), the compressor 12 is coupled, and the compression throttle valve 16 is completely closed. As soon as the exhaust gas turbocharger 18 begins to exhaust the volume after the compressor 12, the waste gate control takes over the adjustment of the desired charge until the desired charge has been reached. Up until this point, the throttle valve 22 is completely open.

CLAIMS

1. Internal combustion engine, especially an internal combustion engine for a motor vehicle, with a charge air flow path, in which a compressor (12), an exhaust gas turbocharger (18), and a throttle valve (22) are arranged, wherein an outlet of the compressor (12) is connected with an inlet of the exhaust gas turbocharger (18), an air channel (14) that bypasses the compressor (12) is provided, and the throttle valve (22) is installed downstream of the exhaust gas turbocharger (18), characterized by the fact that a compression throttle valve (16), which is installed in the air channel (14) that bypasses the compressor (12), selectively closes exclusively this air channel (14) that bypasses the compressor (12) in a continuously variable way and controls compression of the compressor (12).

2. Method for operating an internal combustion engine designed in accordance with Claim 1, characterized by the fact that the compressor is shut off by fully opening the compression throttle valve and disengaging a clutch between the compressor and the crankshaft as soon as the mass flow that the exhaust gas turbocharger is able to deliver on the basis of an exhaust gas mass flow $\dot{m}_{abg}$ exceeds the delivery volume of the compressor.

3. Method for operating an internal combustion engine in accordance with Claim 1, characterized by the fact that when the internal combustion engine is running at full load, the compression valve is completely closed until the exhaust gas turbocharger begins to exhaust the volume after the compressor.

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